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VISUAL AIDS IN HIGH SCHOOL CHEMISTRY

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TABLE OF CONTENTS

TABLE OF CONTENTS

INTRODUCTION

The purpose and problem of this thesis is to determine what visual aids are used and recommended in a high school course in chemistry.

A research in the literature for the background of visual instruction introduces the reader to the problem. In order to determine the desirability of the use of visual aids in chemistry, it was decided to review first the main aims and objectives in the various high school courses in chemistry. It is not the purpose of this paper to originate a new course but to increase the possible teaching efficiency of the present course.

Upon the determination of the aims and objectives, ten chemistry textbooks were surveyed for visual aids used and recommended. From the findings of the survey an attempt is made to show the type of chemistry that is being offered to fulfill the aims and objectives.

There has been much experimentation in the field of visual instruction with some notable forward steps, especially by W. H. Johnson, Frank M. Freeman, Joseph J. Weber, Don Carlos Ellis, Laura Thornborough, L. Paul Miller, A. W. Abrams, Martin V. McGill, A. V. Dorris, Annie Louise Macleod, B. S. Hopkins, F. D. McClusky,

Louis A. Astell, and others. Among the commercial companies Eastman Teaching Films and the Keystone View Company are doing some commendable work. The universities are slowly but surely realizing the value that visual instruction may bring to education as a method.

The Educational Screen, and Visual Instruction News. of late, are magazines performing reliable work in this field. Since this thesis is in chemistry, it is of interest to note the enthusiasm in the revived method of instruction - visual instruction - shown by the Journal of Chemical Education.

CHAPTER I

THE WHAT AND WHY OF VISUAL INSTRUCTION.

THE WHAT AND WHY OF VISUAL INSTRUCTION

Historical Background

Egyptian hieroglyphics probably form the connecting link between ancient picture writing and the early alphabets.[1] Without much discourse that picture writing played such an important part as a medium for transference of ideas, we need only emphasize the fact that the eye held such a commanding position in its ability to train even the crude, prehistoric mind to its present status. There is no need for discussion here of the part played by the abstract mind in the moulding of this civilization, for there is no doubt that there would not be this present mind were it not for the visual perception of the prehistoric man.

About the time 1063 - 1300, the transmutation of the base metals into the noble by means of the Philosopher's Stone formed the cardinal point around which all chemical knowledge was centered.[2] As time went on these alchemists transferred their attention to a search for a great medicine, an Elixir, which it was hoped would be a "cure all". History now records their attempt as a failure. We must be alert and open-minded to claims that visual instruction is to education as the Elixir of the alchemists was to medicine, a remedy for all ills. There is a dangerous over-emphasis when one presumes

1. W. H. Johnson, Fundamentals in Visual Instruction, p.9.
2. Approximation of date from several History of Chemistry Texts.

that visual experience is far more powerful in effecting learning than are any of the other types of experience, auditory, kinesthetic, and so on.[1] We can not overlook the fact that our present civilization was made possible by our sense of vision which enabled us to penetrate mentally our environment.

The Realists and Naturalists

Instruction, in the beginning, was natural. "The father taught the son how to fish and hunt; the mother showed the daughter how to prepare food. This realistic demonstration was accompanied by language as a means to control the learner's thinking."[2] The learning process, therefore, involved seeing, hearing, and doing on the objective side, and thinking or reasoning on the subjective.

We may find many evidences which indicate the early use of visual methods in instruction. The history of education cites a series of revolts against formalism in education. The most notable were led by two groups, one known as the realists, and the other as the naturalists.[3]

The realists believed that the teaching of children from books was secondary in importance to bringing them in direct contact with the real world and nature. To John Amos Comenius (1592-1671) belongs the distinction of introducing visual instruction to the modern world.[4]

1. J. J. Weber, Visual Aids in Education, p. 26
2. J. J. Weber, Picture Values in Education, p. 110
3. E. P. Cubberley, Brief History of Education, pp.213-228.
4. D. C. Ellis and L. Thornborough, Motion Pictures in Education, p. 3

He was convinced that the child could not learn by words alone. Comenius believed that by the use of the objects themselves, when possible, or through pictures, words and ideas could be made real. He carried his conviction through to reality when his textbook, Orbis Pictus, was published. It contained drawings and pictures, and was probably the first textbook to include instructive illustrations. Comenius believed that everything in the intellect comes through the senses.

The second group, known as the naturalists, maintained that the child could be prepared for life only by actually living life and carrying on life activities during the learning period.[1] Rousseau (1712-1778), and Pestalozzi (1746-1827) were the instigators in this form of education, but it was up to Froebel (1782-1852) to carry their ideas into practice.

Visual Instruction and Life Outside the School.

Visual instruction may be found in modern life outside the schools. It may be found in the typical picture advertising found in street cars and places where people may gather. Business firms make use of visual instruction as a means for instructing their employees in the many activities of the firm. Of late visual instruction assumed a very definite and dominating position as a method by which the public may be educated and stimulated. In view of the trend to changes in the organization and

1. W. H. Johnson, Fundamentals in Visual Instruction, p. 10

curriculum of the school by outside pressure, social and economic, it is probable that this tremendous service which visual instruction is rendering outside the school will aid in establishing visual instruction as a desirable method in modern education. Methods of teaching, as well as types of schools, must be modified to fit the changing conditions of society. The tendency of the schools to lag far behind the changes made by society, was in the past of negligible consequence, but today, in the fast changing civilization with its multitudinous, ever accumulating facts, the schools should not lag much behind, in order to cause assimilation with modern methods.

Verbal and Visual Instruction.

We can not overlook the fact that there is an undue prevalence of verbalism, because the actual experience is not always feasible, and often quite impossible. The invention of photography has placed in the hands of the educators a means of unlimited possibilities. As an educational tool language has its limitations.[1] Language can effect a certain amount of learning by challenging the pupil to reorganize his past experiences; but it can not give him new sense-perception. This may be accomplished by actual contacts or realistic experiences. Verbal transfer is an economy in many ways but only when both parties to the exchange of ideas have a common experience. When a specialist tries to convey his ideas to the lay

1. J. J. Weber, Picture Values in Education, p. 110

mind he finds it necessary to amplify or illustrate his thoughts in simple language in order to make the ideas effective with the latter's apperceptive mass.

Visual instruction is not a brand new discovery that will entirely replace our present tendencies in teaching. It is, also, no guaranteed cure for retardation, truancy, imbecility, and incorrigibility. To date there has been but little attempt to formulate the basic principles of this method in education. Visual instruction is not a separate subject of study but rather a teaching aid.

The eye is perhaps the most commonly used of the sense organs. It is generally agreed that a very large part of the knowledge in the possession of the human race has come through the sense of sight. Weber,[1] as a result of his work, "Comparative Effectiveness of Some Visual Aids in Seventh Grade Instruction", suggests conservatively that about forty percent of our conceptual learning may be attributed to visual experience. This figure is more reasonable and accepted by many more than when the method, visual instruction, was reintroduced into education, at which time claims as high as eighty and ninety percent of our learning was attributed to visual experience.

Many modern psychologists ask, "Why can't educational

1. J. J. Weber, Comparative Effectiveness of Some Visual Aids in Seventh Grade Instruction.

procedures deal with actualities and with interests that the child can understand and that will make his work have meaning for him, just like the interesting activities that he will engage in in his later life?"[1] Oral instruction, as a procedure, supplies new experiences only when the subject matter is related to some similar experience of the listener; while visual aids promote the growth of human intelligence in that they serve to make education more natural, more realistic, more interesting, and psychologically sound.[2]

Verbal transfer is an indirect method of presentation at best. The line of least resistance, in teaching, is to lecture and assign lessons in a textbook. We can not help but see many cases in which verbal teaching unaided by concreteness results in a surprising amount of error. Weber, in one of his papers summed up this situation well,[3] "as a child advances in his school work the situation becomes somewhat unbalanced. Seeing realities give way to reading abstract symbols. Language no longer challenges for the reorganization of experience in the solution of a vital problem. Language is forced to become a perplexing substitute for the actual reality. School tasks grow abstract, and learning becomes formal and unnatural." There is great need of more "impressions before we exact expression."[4]

The term "visual aid" in teaching implies a means

1. G. E. Hamilton, How to Use Stereographs and Lantern Slides, pp. 525-529
2. J. J. Weber, Visual Aids in Education, p. 26
3. J. J. Weber, Picture Values in Education, p. 110
4. D. G. Hays, Visual Methods in Chicago Schools, pp. 11-17

of illustration which comes through the eye, and its wise use by an experienced teacher gives to the subject a touch of reality and interest that is difficult to give in other ways.[1] Until we ourselves see it with our own eyes and perceive it with our own understanding, we are as much in the dark and as void of knowledge as before. Visual aids are effective in correcting and enriching the idea which is formed during a lecture. If the pupil has formed a correct reproduction in his mind of an idea during a lecture, or while reading a textbook, the showing of the actual picture will enrich and give color to his imagination. This brings to mind the position held by Montaigne, that "not so much the memory as the observation was to be trained."[2] The most valuable learning takes place when fairly accurate and vivid imagery accompanies the learning of the verbal symbols. Reality in learning is good for all, especially good for the lower mentality. It is dangerous to under-estimate the part played by the abstract word for a small select few, to whom it will usually be sufficient to stimulate the desired imagery leading to learning. For those few, concrete illustrations would only be a waste of time, making the obvious clear, and dulling interest. "One does not absorb, master, or learn any objective thing or fact or subject matter. One learns to make reactions to objects, pictures, printed passages, and so on, reactions which can in some degree be recalled or revived."[3]

1. A. G. Balcom, The Use of Visual Aids in Teaching, p. 9-11
2. M. S. Emerson, The Evolution of the Educational Ideal, p.67
3. E. L. Thorndike and A. I. Gates, Elementary Principles of Education, p. 86

The memorizing of words, and not the mastery of ideas, the procedure known as verbalism, is practiced in many of our major subjects in high schools today.

It has been said that there are four approaches to the learning about a given thing, namely:[1]

1. Studying the thing itself,
2. Studying a picture or a representation of the thing,
3. Being told about it,
4. Reading about it,

and the effectiveness of the approach to any topic is in the descending order.

Experiments conducted by Weber show that visual materials are of distinct value in laying a foundation of concrete experience as a basis for thinking. Not only may more accurate and vivid images be accomplished through visual instruction, but the images are stimulated much more quickly. It is a wrong supposition that the use of visual aids will displace any considerable amount of verbal teaching, but it will and could supplement verbal teaching, and be used in connection with it. Harl R. Douglass claims that visual aids should be resorted to only when the topic presented is of such a nature that the pupils do not have an adequate apperceptive basis, or when the pupil possesses some imagery, but when there is need for more vividness obtainable by fresh experience and not by revived images.

Visual Aids in Chemistry.

In the use of visual aids the primary end to be

1. H. R. Douglass, Modern Methods in High School Teaching, p. 187

kept in view is not that of entertainment. It should be kept in mind by all who wish to employ visual aids, that they are a means to an end, and not the end itself.[1] About fifty years ago those responsible for the teaching of science became aware of the lack of experience in the average student, and so they established the laboratory to provide sensory experiences that would be necessary for a satisfactory understanding of the subject content.[2] This was especially true in the study of chemistry. Today more than ever, there is a need for more realism in presenting new subject matter, and against the psychological waste involved in attempting to supply experience by language alone. L. Paul Miller, in answer to an inquiry made of him, said: "In the teaching of high school chemistry, the most valuable visual aids always have been, and doubtless always will be, chemicals and chemical apparatus." This may well be expanded to more realistic situations such as visits to plants; the knowledge of the uses of the chemicals; and the manipulation of the various apparatus. Visual aids promise to make the understanding of abstract relationships and meanings more effective and economical. This promise is carried out in science by the use of the moving or animated diagram.[3]

Before discussing the various types of visual aids let us see what they are. In the following list we find

1. L. A. Astell. The Status and Trends of Visual Aids in Science, pp. 183-185
2. J. J. Weber, Visual Aids in Education, p. 26
3. W. C. Bagley, Research in Visual Education, pp. 324-326

used as aids to instruction in chemistry

Films	Diagrams
Slides	Demonstrations
Opaque objects	Museums
Charts	Graphs
Maps	Bulletin and Exhibition Boards
Display racks	Collections
Pictures	Exhibits
Trips	

Very often the approach to a new unit of study may be made attractive and interesting by the use of concrete materials. It should be kept in mind by the teacher that the use of any type of visual material should be for some definite teaching purpose. That there should be objectives for its use is pedagogically required. The Handbook of Visual Instruction for the Schools of Schenectady, New York,[1] gives the following as objectives to be obtained through visual instruction:

1. Visual aids make it possible for the mind to obtain necessary imagery.

2. Visual instruction will help the child to observe accurately.

3. Visual instruction brings the world into the classroom.

4. Visual instruction provides a desirable basis for problem solving or reflective thinking.

5. The use of visual aids will make studies more concrete and meaningful.

The objectives enumerated above claim for the visual method in education, what the "Elixir" of old claimed for all ills. It is the real purpose of visual instruction to

1. A. E. Gilbert, Handbook of Visual Instruction for the Schools of Schenectady, N. Y. pp. 4-7

make reality as near as possible to the learner. It is nothing more than a teaching aid, whose proper use gives the desired value.

A. Films.

In order to prevent the formation of a habit psychologized by the constant attendance at movies to view pictures in a state of entertainment, still films or slides have been suggested for school use. It is not always possible to do this, and a film in the hands of a teacher trained in the use of visual aids is not necessary. This can be accomplished by having groups of pupils prepare talks on the film.[1] Furthermore, a good film, pedagogically sound, should always require further study of some kind. The film may be used as a means of motivation, and also for enrichment of ideas. It can arouse curiosity and develop the work spirit.

Experience has indicated that films are most useful when:[2]

1. They immediately follow class assignments and discussion on their topic.

2. They are preceded by suggestive questions on their outstanding points.

3. They are followed the next day by short quizzes on these points.

4. They are accompanied by comments by the teacher while being shown.

1. O. C. Davis, The Use of Motion Pictures in Teaching General Science, pp. 102-113
2. L. P. Miller, The Contribution of Slides and Films to Science Teaching, pp. 200-203

There is danger in asking a department to get too many unnecessary films; for example, in chemistry, to show the effect of oxygen in combustion by means of a film is to do at a great cost what could be done cheaper, and as well, with no expense, by the teacher himself.[1]

It seems to be a fact that a motion picture experiment in chemistry tends to remain fixed in memory even longer than work carried out by one's own hands.[2] While films can never entirely replace laboratory teaching it may take the place of part of it. One instructor could handle larger sections in a laboratory after preliminary training with motion pictures, and time, apparatus, and material would be saved. The question as to when a film should be presented, before or after the mastery of a topic has been answered by Weber.[3] A film shown after the mastery of a unit will no doubt provide new insights, and correct many misconceptions; but it can do all that and more when presented near the beginning. It is not wise to allow the formation of misconceptions; so why not build a solid foundation to begin with. Weber also claims that human beings think more easily from pictures into language than from language into pictures.

Work performed by Wood, Freeman, and Finegan in this branch of visual aids showed:[4]

1. That teachers were able to arouse more interest on the part of pupils with the use of films than without them.

1. A. P. Hollis, Motion Pictures for Instruction, p. 83
2. A. L. Macleod, Visual Instruction in the Teaching of Chemistry, pp. 7-9
3. J. J. Weber, Visual Aids in Education, pp. 37-42
4. T. E. Finegan, Recent Experiments in Classroom Procedure, pp. 958-960

2. That this interest is a sustained interest and that pupils continue to read about, to discuss, and to bring to the classroom material related to the films, many weeks after the films were shown in the classroom.

3. That the children were induced to do more reading and to select books of finer quality. This viewpoint of the teachers is confirmed by local librarians in the several centers where the experiment was performed.

4. That the children were led to correlate features of the film with their own personal experiences, and with community conditions.

The value of the film for school instruction was recognized in 1921 by President Eliot of Harvard,[1] who said, "The moving picture is a valuable means of instruction, and all our school systems ought to seize upon it." Today we find that no high school is considered fully equipped unless it has one or more motion picture machines.[2]

The value of a motion picture is lost when it is introduced in a lesson not requiring the fulfillment of an urgent need. Only the material to meet a definite need should be introduced at this time. Any additional material only distracts the attention and wastes time.

There are two types of films: a film suitable for classroom; and a film suitable for auditorium use. The former is used entirely as a supplementary method in a subject, while the latter may be used as fascinating, wholesome entertainment.[3]

1. W. H. Dudley, Organization for Visual Instruction, p.5
2. W. S. Deffenbaugh, Significant Movements in City School Systems, pp. 18-20
3. Anna V. Dorris, Visual Instruction, pp. 14-22

There are some, particularly Annie L. Macleod, who claim that in chemistry the film should supplement, and to some extent should be substituted for both lecture demonstration and laboratory work.[1] The moving picture would eliminate the necessity of explaining to the class what should have happened and why it did not. A pictured experiment on account of its clearness and exaggerated size is claimed to be better than an actual lecture table experiment for testing and training the students' powers of observation and reasoning.

The rapidity of movement in the film, swiftness of change from point to point, often leads the pupil to be unable to make recall accurately and successfully.[2] This can be overcome by stopping the film and emphasizing various points, while an experiment on the demonstration table takes its own time; it is neither hastened nor retarded to suit the convenience of the lecturer. Holding the experiment at a definite point is not possible. This is natural and is to be desired. As an aid to the teacher who wishes to elaborate and make plain the detailed processes animated diagrams make the "unseen visible." There is a great future for the animated diagrams for use in a chemistry course.[3] A visit to an industrial plant does not give as complete an understanding of a process as does an animated film.

1. A. L. Macleod. Visual Instruction in the Teaching of Chemistry, pp. 7-9
2. Tom Waller, Visual Education
3. O. Walters, Industrial Motion Pictures in the Classroom, pp. 1736-9

B. Slides and Still Pictures.

A good slide represents a large picture, clear in detail and suitable for study with little eye-strain. It remains still so that study and discussion may continue as long as interest lasts. It is a most valuable means for review.[1]

The value of slides in the school was recognized by the Seattle public schools. They have prepared sets of slides to supplement chapter by chapter the texts for use in the various grades.[2]

Stillness, in visual aids, permits better perception and more thinking. Lantern slides can be combined with verbal instruction. The school does not exist for the study of pictures alone. It exists for the learning of whatever the pictures, as substitutes for actual experiences, may have to contribute to learning. There is a danger in using slides too often. This danger is doing for the pupils what they should do for themselves.

Another type of still film is made upon strips of film, which is used with a special attachement to the lantern slide projector. This type of visual aid is less satisfactory than the old glass slide, which is more flexible for use by the teacher.

A projection lantern for opaque objects may be used for projecting lecture experiments. Details often seen only by those in front of the room when performed on the demonstration table may be made clearly visible to every one in the room.[3]

1. A. V. Dorris, Visual Instruction, pp. 14-22
2. Triennial Report of the Public Schools Seattle, 1924-7
3. H. H. Fillinger, The Projection of Lecture Experiments, pp. 1852-1855 Journal of Chemical Education.

Charts, maps, pictures, diagrams, and graphs may be projected for study in the classroom by means of an opaque projector. This type of projection is recommended for chemistry by the committee on visual education of the Journal of Chemical Education.[1] More will be said in regard to the diagram as a visual aid in a following chapter.

C. Display Racks and Exhibits.

In the outline of the course of study of chemistry for the Dallas high schools, the exhibit is used a great deal.[2] Probably next to seeing the real thing, the model as an exhibit, where detailed study and handling can be done, is a most educative visual aid in chemistry.

The shelf can do more than serve as a depository for chemicals in a laboratory. It can be used as a display rack, where all the chemicals that would be used may be handy for immediate reference by the instructor. J. A. Southern was asked by a student: "Why can't we see everything we study about?"[3] The display rack and the exhibit are answers to that pupil and are serving their purpose ideally.

D. Charts, Maps, and Pictures.

Portraits of chemists of historical prominence are attractive additions to the classroom, and often the remembrance of important matters in chemistry will be helped by association with the portrait.[4]

1. Visual Aids in Chemical Education, Journal of Chemical Education, pp. 1341-1349.
2. Dallas High School Course of Study, 1929, p.35
3. J. A. Southern, A Method of Chemical Instruction, Sept.1929
4. Smith and Hall, The Teaching of Chemistry and Physics in the Secondary Schools, p. 203

Nearly all of our education begins with the picture. However, the picture is far from ideal and often gives one wrong concepts and distorted ideas on account of its flatness. Charts add much to the interest and value of instruction, provided they were prepared for the group to which they are shown. Otherwise, the value of the chart is lost. The chart is used a great deal in plotting temperatures, concentrations, and for various other purposes. It should not be used to a great extent in elementary chemistry courses.

Maps are employed to depict worldly distributions of various character. Pupils should be taught to interpret them correctly.

E. Bulletin and Exhibition Boards.

This visual aid should keep the pupils informed of topics in magazines and papers which the instructor deems advisable for their information. Some teachers have a means of follow-up work in order to keep pupils interested in the bulletin and exhibition boards.

F. Trips and Museums.

It can not be too strongly emphasized that no symbol or picture can ever take the place of the trip in which intimate association with the place or thing is the experience.[1] In order that the trip may be educationally successful, experience has shown that pupils should have reached the stage in the development of a lesson where the pupils suggest a field trip. Field trips to local industries

1. Physica and Chemistry, St. Paul, No. 4, p. 17

are part of the outline in the Course of Study at the Olympia, Washington, high schools.[1]

The larger museums have opened school branches which supply the schools with materials for visual instruction. The St. Louis Museum has performed commendable work in this line, supplying schools with objects and pictures for illustrations.[2]

The Demonstration and the Laboratory in Chemistry.

There is entirely too much time given to so-called laboratory work with elaborate and expensive apparatus.[3] Too little attention is given to simple illustrations to be found in every school room and its immediate environments. Some claim laboratory work is useful in that it involves not only seeing but also doing.[4] It gives more realistic experiences which give more accurate and more permanent impressions. This is only true when there is a basic training, a foundation, which would allow impressions to be accomplished, otherwise it is waste of time and money. "The psychology of laboratory work is that it is of value in holding interest and attention and securing clear expression."[5]

Pictures and films can be aids to the teacher to supplement laboratory experiment, until the student has become acquainted with that kind of observation and deduction. The laboratory method has been defended by its advocates on

1. Course of Study, etc., Olympia, p. 57
2. C. G. Rathmann. Visual Education, etc., p. 3
3. J. F. Woodhull, The Teaching of Science, p. 75
4. E. R. Enlow, Visual Aids in High School Instruction, pp. 157-161
5. J. L. Sheean, The Application of Psychology to the Teaching of High School Chemistry, pp. 2181-88

the ground that the manipulation of apparatus and materials develops a scientific attitude and a comprehension of acceptable methods of attack for the solution of new problems.[1]

The demonstration method of presenting laboratory work is used extensively by the chemistry teachers of New England. Demonstrations should be rehearsed in advance, in order to cut down to a minimum the excuse that "if it had worked you would have seen." Demonstrations carried on by the instructor might well be replaced by student demonstrations, using groups or individuals as the occasion seems to suggest. This is a means of attaining class attention and interest, with no discipline problems.

This paper does not aim to evaluate the advantages or disadvantages of laboratory versus demonstration in chemistry teaching, but it does propose the use of pictures - films and slides - as supplements to the laboratory and demonstration methods. It may be more economical to buy a film dealing with an experiment done by a good high school teacher, and have that film on hand from year to year, than it would be to have pupils do that same experiment in the laboratory, or even as a demonstration by the teacher. In this way a good set of film and slides could be developed by experts as a supplement to the lectures and as a means to present a goodly part of the laboratory and demonstration experiments. Later in the year the pupils may enter

1. W. W. Knox, The Demonstration Method Versus the Laboratory Method of Teaching High School Chemistry, pp. 376-386

the laboratory and perform simple qualitative experiments. The use of films or slides would more nearly accomplish the objective of the scientific attitude, for by careful suggestions and follow-up work by the teacher, the pupils will want to do a certain thing suggested by the film to see if it really is so. An inspection of many of our school laboratories suggests that the teachers of chemistry are not making proper use of visual aids in their teaching, because they have no convenient means for storing and displaying charts, specimens, pictures and slides.[1]

SUMMARY

History has shown us that visual instruction is not a new method in modern education. Visual instruction is playing an important part in industry and society outside the school. There can be no doubt that language has its place in the school and education, and that visual aids are not going to displace it in the schools. The use of visual aids in chemistry is quite natural. The place of slides, films, and other visual aids as a supplement to language in chemistry teaching is well founded.

1. Report on Equipment, Apparatus, etc., in Mass., No. 8, 1930, p. 14

CHAPTER II

VISUAL INSTRUCTION AND EDUCATIONAL INSTITUTIONS

VISUAL INSTRUCTION AND EDUCATIONAL INSTITUTIONS

The Need of Teacher Training

In order that visual instruction may function properly as a method, training is necessary.[1] No industrial concern would introduce new machinery into a plant without training its employees in its proper use. This fact should be transferred to the school. Besides teacher training in the use of visual aids, supervision is necessary. In one high school near Boston, I have seen perfectly good chemistry material stored away and never used by the chemistry teacher.

The technique of visual instruction should be mastered to a degree by all connected with pupils in the public schools. In many school systems the head of the visual instruction department instructs teachers interested in the method, in the use of visual aids.[2]

Distribution of Visual Aids by Educational Institutions

The necessity for organized distribution of visual aids to the schools was first seen by the universities. The following list contains twenty Visual Education Departments in state institutions in 1922.[3] This data is supplemented by further data in this chapter of more recent publication.

University of Arkansas	University of New York
University of California	University of Oklahoma
University of Colorado	University of Oregon
University of Florida	Philadelphia Commercial Museum
Indiana University	Texas Agricultural and Mechanical College
Iowa State College	

1. A. V. Dorris, Visual Instruction in the Public Schools, p. 371
2. Ibid, p. 375
3. A. P. Hollis, Visual Educational Departments in Educational Institutions, No. 8, pp. 2-6

Kansas State Normal School
University of Texas
Massachusetts Department of Education
University of Utah
Minnesota University
University of Wisconsin
University of Missouri
Mississippi Agricultural and Mechanical College
North Dakota Agricultural College

The aims and objectives of the above institutions may be summed up as: lecturing and distributing good visual material, giving information in regard to visual instruction, booking films, arranging programs, working up slide sets, assisting instructors in planning use of visual aids in class instruction, and extension work.

In addition to these there is an organized form of distribution of visual aids by the following:[1]

University of Alabama
Alabama Polytechnical Institution
University of Arizona
Georgia State College of Agriculture
University of Kansas
Louisiana State Normal School
University of Michigan
University of Montana
University of Nevada
University of Nebraska
New Jersey State Museum
North Carolina State Department of Education
Ohio State University
Rhode Island State College
University of Tennessee
University of Wyoming

State institutions were the pioneers in establishing departments of visual instruction, but the cities have passed them in the organization and support of these departments.[2] Among them are:

Atlanta, Georgia
Berkeley, California
Buffalo, New York
Detroit, Michigan
Cleveland, Ohio
Chicago, Illinois
Indianapolis, Indiana
Kansas City, Missouri

1. A. P. Hollis, Motion Pictures for Instruction, p. 215
2. A. P. Hollis, Visual Education Departments in Educational Institutions, No. 8, pp. 11-14

Los Angeles, California	Newark, New Jersey
New York, New York	Pittsburgh, Pennsylvania
San Francisco, California	St. Louis, Missouri

Teacher Training

From the various catalogues distributed by colleges the following were found to give courses in visual instruction carrying credit:

University of Alabama
University of Arkansas
Boston University
Clark University
Detroit Teachers College
George Peabody College for Teachers
Indiana University
The College of the City of New York
Kansas State Normal School
Marquette University
Missouri University
New York University
North Dakota Agricultural College
Oklahoma University
Teachers College, Columbia
Texas Agricultural and Mechanical College
Texas University
Utah University

The importance of visual instruction courses was seen by the school systems in many places. During the summer of 1928, fifty educational institutions gave courses in visual instruction to supplement the courses in visual instruction offered by the school systems of Atlanta, Berkeley, Chicago, Cleveland, Detroit, Kansas City, Los Angeles, New York, San Francisco, and St. Louis. In 1929 approximately ninety-five institutions offered courses to summer school students.[1]

In foreign countries there is a great interest in

1. V. L. Kooser, Present Trends in the Use of Visual Instruction Aids, Feb. 1930, p. 56

visual instruction. Germany and France lead in the field of educational scientific films.[1]

Visual Aids Most Used

Of the various types of visual aids used, it was found that the slides led, films a weak second, followed by exhibits.[2] There are many reasons for this proportion. The New York State Legislature as early as 1885 made annual appropriations for lantern slides.[3] The slide was an older and better known visual aid and easier to manipulate, thereby not requiring much attention, as would exhibits and films.

Visual Instruction and the Public Schools.

Visual instruction was brought into the Birmingham Public Schools in 1920-1921. During the first year there were but three schools receiving this service. This number grew to twenty-one in 1924-1925, and to twenty-six in 1930-1931.[4] The motto of this new department is "merely looking is not seeing", which in substance is follow-up work of a definite nature, which is needed in order that visual instruction as a method may be valid.

The centralization of this new department is of great importance, as can be witnessed by the three aims of the Detroit Public Schools in visual instruction; first, the Board of Education should supply the various visual aids; second, this material shall be recorded and

1. V. L. Kooser, Present Trends in the Use of Visual Instruction Aids, p. 144
2. A. P. Hollis, Visual Education Departments, No. 8, p. 28
3. A. W. Abrams, Visual Instruction in the New York Schools p. 284-288
4. Report of Progress, Birmingham, 1931, p. 70

distributed from the library; and third, materials available from public or even private agencies shall be distributed by the library. The library shall be the distributing center for all materials from the department of visual education.[1]

Centralization was struck as a key-note from the very start of the reintroduction of this method. When the World Federation of Education Associations met in 1927, they recognized the value of visual instruction officially by forming a committee to create, first, an international visual aid card index catalogue; and, second, an international bibliography on this field.[2] The Federation was also to act as a medium of exchange of visual aids.

The Berkeley, California, public schools claim that the proper use of visual instruction will stimulate greater interest and render more effective the teaching of each subject.[3]

The New York city schools during the year 1928-1929 gave visual instruction to more than two and a quarter million children.[4]

In order for a high school to be given an "A" or "B" rating in Ohio, the school must have "provisions for visual education, including educational motion pictures at least once a week; and other forms of visual instruction."[5]

1. Detroit Public Schools, Manual for Elementary Schools, p.16
2. W. H. Dudley, Progress of Visual Education in America, pp. 759-767
3. A. V. Dorris, Visual Instruction, pp. 14-22
4. Visual Aids in Chemical Education, J.C.E., pp.828-33
5. Ibid, p. 830

SUMMARY

Teacher training is essential if we are to get the greatest amount of good out of the visual aids. Distribution of visual aids has been taken up energetically by state and city educational departments. Visual instruction courses are offered in many of our universities. The slide outranks the other types of visual aids in proportion used. The introduction of visual instruction was universally accepted as a method by the World Federation of Education Associations. Centralization of visual aids was early recognized as an important factor for distribution.

CHAPTER III

AIMS AND OBJECTIVES IN HIGH SCHOOL CHEMISTRY

AIMS AND OBJECTIVES IN HIGH SCHOOL CHEMISTRY

Why Study Chemistry?

To show the ever-presence of chemistry in our daily life, a speaker at a meeting of business men offered to speak on any object in the room and its relation to chemistry.[1] The principles of chemistry are in operation about us twenty-four hours a day. A science claiming such a fact should be a required subject and not an elective. Chemistry should be studied in order to give the student a broader outlook upon the universe in which he lives, and an appreciation of the chemistry in his community. It is not the aim of this paper to develop in detail such a course. A course of that type should be useful to life. To prepare a course of study for such a subject one should find out what chemistry is needed in life. This, however, is another problem. My purpose is to take a representative course and show what aids are available. Why use them, and how to use them.

Aims and Objectives in Some School Systems.

The general aim in chemistry of the Public Schools of Colorado is: to sell to the pupils an abiding interest in chemistry, both industrial and theoretical.[2] In the Gary Public Schools, the high school course in chemistry is of an industrial nature, relating to the several important industrial processes.[3]

1. H. E. Howe, Chemistry in Industry, p. V
2. A Course of Study for the Public Schools of Colorado, Vol.3
3. O. W. Caldwell, The Gary Public Schools, Science Teaching p. 59

Aims of the Division of Chemical Education of the American Chemical Society are:[1] "To show the service of chemistry to the home, to health, to medicine, to agriculture, to industry; in a word, to show the service of chemistry to the country. To develop this service in chemistry around certain minimum fundamental topics and, in doing so, to see that these minimum requirements are so well taught that they may be built upon as a foundation in college. To build upon the earlier science courses and knit them together in the best possible manner. To encourage students to use reference books in addition to their texts."

The underlying aim of an elementary course in chemistry is to familiarize the pupil with the everyday chemistry of his environment.[2] It is not possible in a year's course to give more than a very sketchy generalization of what chemistry is. R. K. McAlpine believes that since only seven and one-half percent continue work in chemistry it is hardly sufficient to warrant setting up training for college chemistry as a major aim in the secondary school.[3] The high school chemistry of the future should have the definite aims of giving the students an understanding of the fundamental chemical processes that affect daily life. At the same time it is a good preparation for those who will enter wider courses in college.[4] Chemistry has ceased to be a college preparatory subject.[5] This is hardly the case. An examination of courses reveals that

1. Teaching of Chemistry in the High Schools, School and Society, p. 264.
2. R. K. McAlpine, Some Aims in Teaching Elementary Chemistry, pp. 154-164
3. Ibid, p. 154
4. J.O.Frank, Teaching First Year Chemistry, p.7
5. High School Course of Study, The Sciences, Dallas, Texas, p. 35

most courses are still not recognizing the chemistry of everyday life. It holds as much interest and usefulness for those who do not plan to go to college as for those who do. It aims to develop in the pupil an appreciation of the significance and the importance of chemistry in the affairs of the world, the nation, and man's daily life.

Still another aim in chemistry is shown by the Los Angeles City High Schools, whose course is intended for those students who expect to go to college, enter commercial work, or who desire chemistry for its cultural value.[1]

The aims of the chemistry course in Kansas High Schools are; first, it should show how chemistry enters into the daily life of the human race; second, it should give the student something of the meaning of the subject and create the desire to learn more about chemistry. Use of industrial films, visits to industrial plants, and the cessation of too much emphasis on the dangers and difficulties of chemistry are means of attaining these aims.[2]

The aims of the chemistry course of the San Francisco Public Schools are in substance: first, to reveal the far-reaching and underlying importance of chemistry in its relation to all material things and to give an insight into the wonderful system employed by nature in conducting and transforming her endless array of substances; second, to awaken the pupil's interest in the chemical phenomena about him and to increase his appreciation and comprehen-

1. Los Angeles City High Schools, Monographs, No. 34, School Publication No. 98, p. 30
2. Course of Study for the High Schools, Science, G. A. Allen, Topeka, 1930, p. 44

sion of such things, so that he may be able to apply facts and principles to the contacts of his everyday life; and, third, to show the relation of chemistry to other sciences.[1]

One of the aims of chemistry in the High Schools of the State of Washington is very significant and agreed upon by many school systems; it is, to develop the service of chemistry to the country around minimum fundamental topics, and in doing so, to see that these minimum requirements are so well taught that they may be built upon a foundation.[2]

The aims and objectives in the various school systems may be summed up as follows: to give the student a broader and fuller conception of his environment, and the laws of nature; and also at the same time, to give a knowledge of basic facts and principles thorough enough to allow understanding the topics discussed, and incidentally to prepare for college entrance examinations. In many of the schools around Boston, preparation for college entrance examinations is not incidental but basic in the make-up of the course of study in chemistry.

Mr. Allen in an article[3] says that, "the average high school student will never be a chemist and will probably never directly use chemical knowledge. The high school can lay an apperceptive basis for further study of chemistry in a formal way, if the student goes to college.

1. San Francisco Public Schools, Science, Bulletin No. 210,p.28
2. State of Washington, Course of Study, 1930, p. 56
3. Mr. Allen, High School Chemistry, Teachers College Record, Vol. 11, pp. 55-58

It can bring him in contact with chemistry as a field of human activity by showing him, to a small extent, what chemists do, the nature of chemical problems, how they are attacked, and solved."

Methods in Attaining the Aims.

By a method in education is meant the way in which an instructor applies an educative agent or agents to work upon human nature so as to produce some desired result. A good method is a means of motivation. In order to motivate a school subject it is necessary only to give it vital connection with the pupil's present interests.[1] In order to attain the aims, the methods of instructing should be:[2]

1. Interest the pupil in his surroundings

2. Interest the pupil in any local chemical industry

3. Make the pupil think; do not expect him to re-discover chemical laws, or prove them.

The question, as a part of a lecture method, if correctly used, stimulates thought, leads to inquiry, and results in understanding and mastery.[3]

In Chapter I we have discussed the use of visual aids as a method and also the demonstration and the laboratory. We may see that in order to digest the fast accumulating knowledge of chemistry, the method of visual instruction is a means of motivation. Herbert L. Spencer[4] said: "the use of visual aids effects an

1. H. B. and G. M. Wilson, The Motivation of School Work, p.15
2. C. H. Johnston, High School Education, pp. 183-198
3. G. H. Betts, The Recitation, pp. 33-35
4. H. L. Spencer, Training Teachers to Recognize Vital Values in Education, pp. 920-923

economy in time in teaching." To interpret this to mean that it shortens the school year is wrong, but it does mean that more knowledge can be put over in the same time. Visual instruction as a method fulfills one of the aims in chemistry, that of realism. Every method employed should approach a unit in chemistry from daily life phenomena.

SUMMARY

We should study and know some of the fundamentals of chemistry, on account of its ever-presence. The aims and objectives in chemistry are many, but in substance they are the realization and knowledge of the part played by chemistry in our daily life. The method is the means of attaining the aims, and visual instruction as a method in chemistry has long found its place.

CHAPTER IV

A SURVEY OF VISUAL AIDS IN TEN CHEMISTRY TEXTS

A SURVEY OF VISUAL AIDS IN TEN CHEMISTRY TEXTS.

The Diagram

In this survey, ten chemistry texts recommended for high school use were surveyed for visual aids. The most common visual aid found in the text was the diagram; the photograph was second in number; and third, maps. This shows the tendency towards using more visual aids. The modern text book is more visualized than the older books. The proper use of the aids determines the value to be derived. There is little value in a picture of a liquid air compressor in a high school chemistry text, when there is no explanation about it in the body of the text.[1] Merely labeling a picture with a title has little teaching value. The greater part of the diagrams are referred to by the standard phrase, See Figure Blank, and nothing more; good teaching requires more than mere showing.

Since everything in chemistry is new to the beginning student, the language, apparatus, and subject matter should be taught through as familiar previous subjects as is possible, and through materials he can handle.[2] It is not helping a beginner through visual aids to look at an unfamiliar flat photograph, or an inanimate diagram. It is my opinion that a good project would be to make a set of animated diagrams of the most commonly difficult diagrams in the common texts. There can be no doubt of the important place in scientific study and investigation that the animated diagram is achieving.[3]

1. C. E. Dull, High School Chemistry, p. 173
2. Los Angeles City High Schools, Monographs, No. 34, p. 31
3. A. V. Dorris, Visual Instruction, p. 10

The Chemistry Textbook.

There are some teachers who prefer not to use any one definite book, and instead refer the pupils to certain readings in the school library. To throw the pupil on his own resources is a fine idea, but this is going too far with beginning pupils.[1] It is advisable for beginners in a course to use a common text, because no elementary pupil will have to make a study of any complete chemical change. This was the main reason for the choice of a text, and following it. In this manner the subject matter of the course was determined by the content of the textbook. Since the most common chemistry texts used in high schools are nothing but boiled-down college texts, the outline of the courses in high school chemistry are so much the same, following basicly, preparation for college, instead of a knowledge of the relationship of chemistry to every-day life, from a practical standpoint.[2] The high school chemistry text in the future should be prepared by teachers who know this new aim. This dissertation does not mean to denounce in whole the high school chemistry texts used today. For from figures to be given soon, it will be seen that many schools use just this type of text, but the odd part of the affair is that the texts do not fulfill the aim of a high school chemistry course, but that the teacher with his methods was able to use the particular texts. Again we have the importance of methods, particularly the return of the visual

1. A. Smith and E. H. Hall, The Teaching of Chemistry and Physics in the Secondary School, p. 136.
2. J. O. Frank, Teaching First Year Chemistry, p. 8

method. A good teacher is the most important factor in any chemical course of study. Superior texts and skillfully prepared outlines are of no avail without him.[1]

A good chemistry text holds its place with the lecture and the laboratory. In an experiment performed by W. H. Wiley,[2] he found that there is not as much difference as is supposed by many in the values of the lecture, text-book, and laboratory, so far as imparting knowledge is concerned. As the survey will show, the better texts contain many diagrams as a method of explaining facts, but very few of the diagrams are self-explanatory. The State of New Mexico, Department of Education, believes that the diagrams of the texts are not sufficient for concreteness and recommend visual aids, such as slides, filmslides, and motion pictures to supplement them.[3] Modern methods in education have gone beyond the mere use of the textbook and its traditional contents. It is a means of giving information, but not the only way.[4] It may be observed that pupils grow weary of their books, because they are books, because they are filled with things that have to be explained by the aid of words. When a pupil reads, one of three situations may occur:[5] first, the pupil may visualize a clear and correct mental picture of the thing he is reading about; second, he may visualize an incorrect or inadequate picture of it; and, third, he may visualize no picture at all. With these three possibilities from one reading, it is an absolute necessity

1. W. Segerblom, Methods and Helps in Teaching High School Chemistry, pp. 467-480
2. F. D. Curtis, Investigations in the Teaching of Science, pp. 42-46
3. High School Course of Study in Science, New Mexico, No. 2
4. W. L. Fisher, Visual Instruction, pp. 13-16
5. G. E. Hamilton, How to Use Stereographs and Lantern Slides, pp. xiv-xxii

that we know where the pupil stands. However, by means of supplementing the reading with sound visual aids we put the pupil into the first situation.

There is no doubt that books and printed matter have found their place as a tool; but there are books, and books, just as there is a kitchen clock and the Naval Observatory clock. The former could be of value to the housewife, while the latter is a puzzle with no meaning. There must be no such answer to the teacher by pupil as Hamlet gave Polonius when he asked,[1] "What do you read, my Lord?" and Hamlet replied, "Words, words, words." This can be overcome by giving the pupil a book that he can understand, that is not mere words, but picture building ideas.

John F. Woodhull[2] stresses the value of the teacher and methods when he says, "Our text-books in chemistry are chiefly encyclopedias, or, in some cases, dictionaries. They are not properly speaking text-books. They should be treated as books of reference and not courses of study."

Aims of the Chemistry Texts

Since every author of a textbook usually gives his reason and aims for writing his text, it would be worth while to review some of the aims of several of the texts surveyed.

1. C. G. Rattmann. Visual Education and the St. Louis Museum, No. 39, p. 1
2. J. F. Woodhull, The Teaching of Science, pp. 231-2

High School Chemistry written by Charles E. Dull,[1] has for its aim to make his book practical, and to show the relation of chemistry to every-day life without neglecting the fundamental principles upon which chemistry is based. The relation of chemistry to water purification, fuels, paints, textiles, paper, and so forth are especially emphasized. It is my opinion that this aim is a good one, but the means of bringing this about is not shown by the author. The aim is but an aim, seldom reaching its fulfillment.

William Foster's The Romance of Chemistry[2] has a more practical aim. The author fully realized the difficulty of writing a chemistry text, for the subject of chemistry is so vast that only a limited number of topics can be treated in a single volume.

Lyman C. Newell's Brief Course in Chemistry[3] has as its basic aim the fulfillment of the American Chemical Society's minimum course in chemistry. From these minimum topics the teacher is to interest the pupils in the course of chemistry by showing the service of chemistry to the home, community, and the nation. The text serves two classes of students, those who will go to college, and those who will not.

High School Chemistry by George H. Bruce[4] has included material which is listed in the syllabus of the American

1. C. E. Dull, High School Chemistry, preface
2. W. Foster, The Romance of Chemistry, preface
3. L. C. Newell, A Brief Course in Chemistry, preface
4. G. H. Bruce, High School Chemistry, preface

Chemical Society. In addition, he has included subject matter that he has found of interest to students.

Elementary Principles of Chemistry[1] written by Brownlee, Fuller, and Others, attempts not to present in too large doses at one time theoretical matters. The authors realize that a constant danger in beginning chemistry is the mechanical teaching of memorized facts and processes, and attempt to prevent it.

Practical Chemistry by Lyman C. Newell[2] is a book whose aim is to present illustrated and applied chemistry. It contains topics suggested by the College Entrance Examination Board, and the Board of Regents. The author feels that the teacher needs a text which is carefully selected, judiciously apportioned, and properly arranged.

Without going further we may conclude that the aims of the majority of texts are, first, the teaching of the fundamentals of chemistry; and, second, their relation to the environment. The text, to the slightest degree, suggests methods in presenting the contents. It is left to the teacher to add to the text supplementary material.

Glossary to the Survey

In order to have a uniform means - that of tables - of surveying the ten texts chosen, it was first decided to set the chemistry course off into Units of work, so that each diagram will find its place in some one Unit. From a search in the literature for a suggestion as to the division of a year's course, I have found that

1. Brownlee, Fuller, and Others, preface
2. L. C. Newell, Practical Chemistry.

Russell S. Howard has divided the course into eight Units.[1] He stresses the value of the correct interpretation of the word unit and calls attention to the danger of calling a topic a unit. For, if a unit is nothing more than a chapter heading, we have gone no further in outlining a course in chemistry into true units. We can not escape the fact that recall and retention are the off-springs of association.[2] If that is true, by making our course of chemistry into units, our recall and retention is increased because we have in a unit of work more related topics, therefore, wider association.

The eight tables were compiled by assigning to each book a letter as follows:

A stands for The Romance of Chemistry, William Foster, The Century Company, New York, 1927

B stands for Elementary Principles of Chemistry, Brownlee, Fuller, Hancock, Sohon, and Whitsit, Allyn and Bacon, 1926

C stands for Chemistry for Today, McPherson, Henderson and Fowler, Ginn and Company, 1930

D stands for An Introduction to Chemistry, a Pandemic Text, John Arrend Timm, McGraw-Hill Book Company, New York, 1930

E stands for Fundamentals of Chemistry, Gray, Sandifur, and Hanna, Houghton Mifflin, Riverside Press, 1926

F stands for High School Chemistry, George H. Bruce, World Book Company, Yonkers, 1928

G stands for High School Chemistry, Charles E. Dull, Henry Holt and Company, New York, 1925

H stands for Practical Chemistry, Lyman C. Newell, D. C. Heath and Company, Boston, 1929

1. R. S. Howard, Some Aspects of the Unit Method; Univ. of Ill., Vol. 28 and Vol. 26, pp. 296-311, 324
2. H. R. Douglass, Modern Methods in High School Teaching, p. 153

I stands for A Brief Course in Chemistry, Lyman C. Newell, D. C. Heath and Company, Boston, 1929

J stands for Practical Chemistry, Black and Conant, The Macmillan Company, New York, 1929

The sub-titles under each unit title are a description of the various diagrams. In many cases the authors of the several books may find that they were not given credit for each diagram in their books. The reason for this is that in many cases more than one diagram fulfilled the description of the sub-title, in which case only one check was used. Since every book surveyed was done by the writer under the same conditions, it is held that the survey in that respect is valid. Before anything further can be said on the tables it would be of value to the reader to glance through them.

TABLE I UNIT I MATTER UNDERGOING CHANGE.

	A	B	C	D	E	F	G	H	I	J
The electrolysis of water- - - - -	✓	✓	✓	✓		✓	✓	✓	✓	✓
Relative abundance of elements - -	✓									✓
Preparation of oxygen - - - - - -	✓	✓	✓			✓	✓	✓	✓	✓
" " " from mercuric oxide- - - - - - - -		✓	✓			✓				✓
Oxygen cylinders - - - - - - - - - -						✓		✓		
Preparation of hydrogen and properties- - - - - - - - -		✓				✓	✓	✓	✓	✓
The hydrogen flame - - - - - - - -		✓	✓					✓	✓	
Preparation of hydrogen by action of sodium on water- - - - - - -			✓			✓			✓	✓
Liquefaction of air- - - - - - - - -	✓		✓	✓	✓	✓	✓		✓	✓
A Dewar flask for liquid air - - -		✓		✓			✓	✓		✓
Formation of hydrogen by steam over heated iron- - - - - - - -								✓		
Oxidizing and reducing flames- - -						✓		✓		✓
Ozone generator- - - - - - - - - -										✓
The candle flame - - - - - - - - - -	✓	✓	✓		✓	✓	✓	✓	✓	
Hydrogen as a deoxidizing agent- -		✓								
Kipp generator - - - - - - - - - - -		✓					✓	✓		✓
Preparation of carbon dioxide- - -		✓	✓			✓				
Testing of carbon dioxide - - - -		✓						✓	✓	✓
Escape of carbon dioxide from carburated beverages - - - - - - - -								✓	✓	✓
Liquid carbon dioxide- - - - - - - -										✓
Allotropic forms of carbon(diamond)		✓			✓				✓	✓
Preparation of carbon monoxide - -		✓								✓
Charcoal and other products from wood distillation - - - - - - - -			✓				✓		✓	✓
The disintegration of the Uranium-Radium series - - - - - - - - - -	✓									✓
Acetylene cutting- - - - - - - - -		✓				✓	✓	✓	✓	
Transformation and conservation of matter- - - - - - - - - - - - - -			✓		✓	✓				
Oxyhydrogen blowpipe - - - - - - - -		✓								
Laboratory blast lamp- - - - - - -			✓					✓		✓
The Miner's safety lamp- - - - - -			✓	✓		✓		✓		
An electric arc furnace- - - - - -			✓							
" " resistance " - - - - - - -			✓				✓			
An automobile carburetor - - - - -		✓	✓		✓					
Products from the air- - - - - - -			✓		✓					
Comparison of temperature scales -				✓	✓	✓		✓		✓
Lavoisier's apparatus for study- - of combustion- - - - - - -						✓				✓
Construction of a Bunsen burner- -						✓	✓	✓	✓	✓
Distribution of carbonates - - - -					✓					
Comparison of metric and Eng. units							✓			
Simple barometer - - - - - - - - - -		✓				✓	✓	✓	✓	✓
Dessicator - - - - - - - - - - - - - -							✓	✓	✓	
Charring of sugar by sulphuric acid										✓
Totals for Each Book for Unit I- -	6	17	16	5	8	18	14	20	16	25

TABLE II UNIT II WATER, SOLUTION, AND CRYSTALLIZATION

	A	B	C	D	E	F	G	H	I	J
The Permutit Process - - - - - - - -	✓	✓	✓				✓		✓	✓
Filtration of water - - - - - - - -	✓		✓	✓	✓	✓	✓			✓
Distillation of water- - - - - - - -		✓	✓		✓	✓	✓	✓	✓	✓
Bacteria in impure water - - - - -			✓							✓
Effect of temperature on solubility					✓			✓	✓	✓
Solubility of salt and saltpeter -		✓								✓
Composition of water by weight and volume - - - - - - - - - - - - - -			✓			✓	✓		✓	✓
Steam heating - - - - - - - - - - -							✓			
Gravity type of mechanical filter-							✓			
Pressure " " " " -							✓			
Liebig condenser - - - - - - - - - -									✓	
Water formed by burning hydrogen -										✓
Alum crystals deposited from a concentrated solution - - - - -								✓	✓	
Sodium chloride crystal - - - - -				✓						
Purifying water by chlorine- - - -										✓
The comparative use of water and foam in extinguishing fire - - -			✓			✓	✓			✓
Immiscible liquids - - - - - - - - -										✓
Totals for Each Book for Unit II	2	3	6	2	3	4	8	3	6	11

TABLE III UNIT III THE GENERAL PROPERTIES OF GASES.

	A	B	C	D	E	F	G	H	I	J
Transfer of gases to show weight -		✓	✓							✓
Variation of volume with pressure-				✓						
Osmosis - - - - - - - - - - - - - - -				✓		✓	✓			✓
Faraday's apparatus for liquefying gases - - - - - - - - - - - - -				✓						
Weight of 22.4 litre of gas (various)- - - - - - - - - - - -						✓				
Diffusion of (Bromine) vapor- - - -										✓
Volume measurement of gases and pressure - - - - - - - - - - - -				✓		✓	✓			✓
A Claude machine for liquefying gases- - - - - - - - - - - - - -					✓					
Totals for Each Book for Unit III	0	1	1	4	1	3	2	0	0	4

TABLE IV UNIT IV THE ATOM AND MOLECULE.

	A	B	C	D	E	F	G	H	I	J
The hydrogen atom - - - - - - - - -	✓									
Weight of a litre of oxygen - - -								✓	✓	
The hydrogen spectrum - - - - - -				✓						✓
The spectroscope - - - - - - - -						✓	✓			
The helium atom - - - - - - - - -	✓					✓				
Atoms in a crystal of salt - - -										✓
The structure of the atom - - - -			✓		✓					
Ring diagram of some elements - -		✓				✓				✓
The importance of weight in chemistry- - - - - - - - -		✓								
Totals for each Book for Unit IV	2	2	1	1	1	3	1	1	1	3

TABLE V UNIT V VALENCE, IONIZATION, ACIDS, BASES AND SALTS.

	A	B	C	D	E	F	G	H	I	J
Illustrating valence - - - - - - --	✓	✓		✓		✓	✓			✓
Preparation of hydrochloric acid-		✓	✓			✓				✓
Electrolysis of " " -		✓						✓	✓	✓
Commercial preparation of " " -			✓		✓			✓	✓	
Hydrochloric fountain- - - - - -								✓	✓	✓
Burrettes for neutralization- - -		✓						✓	✓	✓
Testing solutions for conductivity	✓	✓	✓			✓	✓	✓	✓	✓
Contact process for making sulphuric acid- - - - - - - - - --		✓	✓		✓			✓	✓	✓
The lead chamber process for making sulphuric acid - - - - - - - - -		✓			✓	✓	✓	✓		✓
Dehydrating property of sulphuric acid - - - - - - - - - - - - - - -		✓								
Preparation of hydrogen sulphide-			✓							✓
Hydrogen sulphide flame - - - - -										✓
Electrolysis of salt- - - - - - - -		✓						✓		✓
The castner process for electrolysis of brine - - - - - - - - - -		✓	✓							
Pumping salt solutions from deep beds		✓								
Products derivable from salt- - -					✓		✓			
Preparation of nitric acid- - - -		✓	✓		✓	✓	✓	✓	✓	✓
Test for nitrate- - - - - - - - - -		✓								
Fire extinguishers - - - - - - - -		✓	✓	✓		✓	✓	✓	✓	✓
Preparation of copper sulphate- -		✓								
Electrolysis of " "- - - -							✓			
" " cupric chloride- -						✓				
Solvoy process for sodium carbonate									✓	✓
Etching with hydrochloric acid- -					✓			✓	✓	✓
Electroplating- - - - - - - - - - -		✓						✓		
Ionization of silver chloride - -					✓					
Specific gravity of sulphuric acid by hydrometer- - - - - - - - -									✓	
Totals for Each Book for Unit V	2	16	8	2	7	7	7	12	11	15

TABLE VI UNIT VI THE NON-METALS AND THEIR RELATIVES

	A	B	C	D	E	F	G	H	I	J
Sulphur Wells (Frasch process)- -	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Allotropic forms of sulphur - - -		✓	✓				✓			✓
Preparation of sulphur dioxide- -		✓				✓				✓
Sulphur dioxide bleaching - - - -		✓					✓			✓
Burning of sulphur in oxygen- - -			✓			✓		✓	✓	
Preparation of sulphur trioxide -			✓							✓
Products of sulphur - - - - - - - -					✓					
Sulphur dioxide as a refrigirant-							✓			
Purifying sulphur - - - - - - - - -								✓		
Cylinders of liquid sulphur dioxide								✓		
Electrothermal furnace for carbon disulphide - - - - - - - - - - -								✓	✓	✓
Synthetic ammonia by the Haber process (and lab. process)- - -	✓	✓	✓			✓	✓	✓	✓	✓
Solubility of ammonia in H_2O - -		✓			✓				✓	✓
Principles in " ice machines - -		✓	✓			✓	✓		✓	✓
How electric household refrigerator operates- - - - - - - - -			✓							
Phosphorous burning in oxygen leaving nitrogen - - - - - - - -		✓	✓			✓		✓	✓	✓
Preparation of nitrogen from air-		✓								
The Arc process for preparation of nitrogen - - - - - - - - - - - -		✓								
The nitrogen cycle- - - - - - - - -							✓			✓
Explosives- - - - - - - - - - - - - -										✓
Preparation of nitric oxide - - -			✓			✓				
" " nitrous oxide- - -						✓				✓
" "nitrogen dioxide- -										✓
The electrolysis of salt to prepare chlorine- - - - - - - - - -		✓							✓	
Preparation of chlorine - - - - - -		✓	✓			✓		✓	✓	✓
The Nelson cell for preparation of chlorine and sodium hydroxide -		✓								✓
Isotopes of chlorine- - - - - - - -		✓								✓
The Vorce cell for preparation of chlorine- - - - - - - - - - - - -			✓							
Bleaching effect of chlorine- - -							✓			
" of cotton cloth- - - - - - -		✓				✓	✓	✓	✓	✓
Preparation of bleaching powder -		✓	✓				✓			
Preparation of bromine- - - - - - -		✓	✓			✓		✓	✓	✓
Test for bromine- - - - - - - - - -		✓	✓							
Electrical manufacture of phosphorus- - - - - - - - -		✓					✓	✓	✓	✓
A match - - - - - - - - - - - - - -		✓								
Apparatus for preparation of fluorine - - - - - - - - - - - - - -		✓								

Continued on page 45

TABLE VI UNIT VI (CONT'D.)

	A	B	C	D	E	F	G	H	I	J
Preparation of fluorine by electrolysis of hydrogen fleuride - - - - - - - - - - - - -						✓				
Preparation of iodine - - - - - - -						✓				✓
Phosphine preparation- - - - - - -	✓									
Manufacture of carborundum - - - -		✓								✓
Distribution of silicates - - - -					✓					
A glass furnace- - - - - - - - - - -		✓								
Oxygen - carbondioxide cycle and plants - - - - - - - - - - - - - -		✓			✓		✓	✓	✓	✓
Totals for Each Book for Unit VI	3	24	14	1	6	14	13	12	13	22

TABLE VII UNIT VII THE PROPERTIES OF METALS AND THEIR COMPOUNDS.

	A	B	C	D	E	F	G	H	I	J
A blast furnace		✓	✓	✓			✓	✓	✓	✓
The Bessemer converter		✓	✓			✓	✓	✓		✓
An open-hearth steel furnace		✓	✓	✓	✓	✓	✓		✓	✓
Steel alloys					✓					
Dipping iron grating into dilute H_2SO_4 before galvanizing					✓					
The reverberatory furnace for the manufacture of wrought iron						✓	✓		✓	✓
Sprinkler heads							✓	✓	✓	✓
Electric furnace for making steel							✓	✓	✓	✓
Welding steel rail with thermite								✓		✓
Converter for steel from cast iron									✓	
Sodium by the electrolytic process		✓						✓		✓
Cast iron into wrought iron		✓								
A Castner cell for the production of Na			✓		✓	✓				
Passing steam over heated iron		✓						4		
Manufacture of calcium		✓						✓		
" " " carbide		✓	✓					✓		
Boiler scale					✓					
Calcium cyanamide as a fertilizer							✓			
Lime kiln (rotary and vertical)		✓		✓		✓	✓	✓	✓	✓
Cement kiln		✓						✓	✓	✓
The electrolytic production of aluminum			✓		✓	✓		✓	✓	✓
Some alloys used in an auto			✓							
Copper nickel alloys				✓						
Magnesium-tin alloys				✓						
Reducing copper oxide with carbon monoxide										✓
Preparing copper sulphide										✓
Copper from copper-sulphur-iron-ore								✓	✓	
Electrorefining of copper				✓				✓	✓	
Storage battery			✓	✓						
Preparation of iron sulphide						✓		✓	✓	✓
Preparation of white lead							✓	✓	✓	✓
Manufacture of magnesium by the electrolysis of carnallite								✓		
Quartz crystals								✓	✓	
Blowing glass							✓			
Retorts for reduction of zinc oxide									✓	✓
Preparation of ferrous chloride										✓
Cyanide mill for extracting gold and silver from the ore					✓					
Steps in the production of photographic film			✓	✓						
The use of mordants in dyeing			✓							
Cleaning mercury by dropping through nitric acid										✓
Reduction of hot copper oxide by a stream of hydrogen		✓	✓			✓	✓			✓
Totals for Each Book for Unit VII	0	11	11	8	7	8	11	17	15	19

TABLE VIII UNIT VIII ORGANIC CHEMISTRY,
The Compounds of Carbon.

	A	B	C	D	E	F	G	H	I	J
Bomb colorimeter - - - - - - - - - -										✓
Industrial chart - - - - - - - - - - -										✓
Showing composition of food - - -	✓		✓		✓			✓	✓	✓
Starch from plants - - - - - - - - -		✓				✓				✓
Textile fibres - - - - - - - - - - - -			✓		✓		✓			✓
Making rayon threads - - - - - - - -			✓							
Coal gas from soft coal - - - - -		✓			✓	✓	✓	✓	✓	✓
Distillation of petroleum - - - -		✓		✓	✓		✓	✓	✓	✓
Products from soft coal - - - - -			✓		✓		✓			✓
Section of earth's crust showing layers of coal - - - - - - - - - -								✓	✓	
Lard substitute from cotton seed oil - - - - - - - - - - - - - - - - -						✓				
By product coke oven - - - - - - - -				✓	✓					
Carbon oxides in a coal stove - -	✓	✓	✓					✓	✓	✓
Producer gas - - - - - - - - - - - - -	✓	✓	✓			✓	✓		✓	✓
Water gas - - - - - - - - - - - - - -		✓				✓	✓		✓	✓
Totals for Each Book for Unit VIII	3	6	6	2	6	5	6	5	7	11

In a survey of the frequency of the occurrence of chemistry texts in the high school, Malin[1] found that Brownlee, Fuller, Hancock, and Others, is much used. There were ninety-six replies representing every state in the Union with the exception of Nevada. The latter two books in the list were not in the survey, but were used in this paper. The frequency of the basic texts are as follows:

		Number of schools using
Brownlee, Fuller, and Others	(B)	33
Black and Conant	(J)	13
McPherson, Henderson and Fowler	(C)	10
C. E. Dull	(G)	9
Gray, Sandifur and Hanna	(E)	7
G. H. Bruce	(F)	4
L. C. Newell (each book 2)	(H and I)	4
Timm	(D)	0
William Foster	(A)	0
		80

The number of diagrams, which is the visual aid most used by the common texts, seems to go hand in hand with the popularity of the text, with the exception of Gray, Sandifur, and Hanna's book, as may be seen from the following Table A of totals of diagrams in the various texts. This is an indication of the desirability of visual aids as a means of presentation of the substance in words into more realism.

1. J. E. Malin, A Brief Survey of the Mechanical Fundamentals of High School Chemistry, p. 149

TABLE A

	A	B	C	D	E	F	G	H	I	J
Table I Unit I	6	17	16	5	8	18	14	20	16	25
Table II Unit II	2	3	6	2	3	4	8	3	6	11
Table III Unit III	0	1	1	4	1	3	2	0	0	4
Table IV Unit IV	2	2	1	1	1	3	1	1	1	3
Table V Unit V	2	16	8	2	7	7	7	12	11	15
Table VI Unit VI	3	24	14	1	6	14	13	12	13	22
Table VII Unit VII	0	11	11	8	7	8	11	17	15	19
Table VIII UNIT VIII	3	6	6	2	6	5	6	5	7	11
Totals for Each Book	18	80	63	25	39	62	62	70	74	110

The survey proves that one of the factors for the choice of a text is the content illustrated material.

SUMMARY

The diagram has a limited means of visual presentation of facts. It may be employed as a means of organization and summary; but is nearly useless without facts, or previous training and study. It is best for elementary pupils to use some definite text. The textbook has its place in modern education, even as the teacher, and visual aids do not plan to replace either, but supplement both. College preparation, and to a slight degree, relation of chemistry to everyday life, are the keynotes of the majority of high school chemistry textbooks. The degree to which the latter keynote is carried out

by the textbooks is not high. The unit in chemistry is pedagogically sound. The frequency of illustrated material in chemistry texts in the high schools is one of the measures used for the choice of a textbook.

CHAPTER V

A COURSE OF STUDY WITH VISUAL AIDS FOR HIGH SCHOOL CHEMISTRY

A COURSE OF STUDY WITH VISUAL AIDS FOR HIGH SCHOOL CHEMISTRY.

What Type of Chemistry should be given in High School?

In St. Louis, a survey showed that fifty-eight percent take chemistry for the purpose of taking college entrance examinations.[1] The survey concluded that this may also be the case in other school systems. If that is true, a course suitable for this group and the other forty-two percent must be given. The question arises as to how many enter college who take chemistry, and at once we realize in answering, that a type of chemistry should be given that will suit the majority in life. Fifty-eight per cent do not go to college.

The new aim in chemistry is to give the pupil an understanding of the chemistry experiences of everyday life. From these experiences the fundamental chemistry concepts and principles may be evolved to fit those who want to go to college. This type of course fulfills the Unit plan in outlining the high school chemistry course. The Unit plan does not consider the every-day chemistry of cleaning agents, foods, preservatives, textile fabrics, paints, and so forth as optional topics of study, but as part of some unit of work.

In the course of study to follow, the visual aids suggested under each unit, will function successfully when proper presentation and discussion accompanies the visual aid.[2]

1. Chemistry for the High School, No. 32, St. Louis
2. C. G. Rathmann, Visual Education and the St. Louis Museum, No. 39, p. 3

The practice made in the past was to assign a list of topics to be read outside of school.[1] These topics contained the most common every-day problems involving chemistry. No visual perception of these familiar topics were left with the pupils, only words, and more words. It has been found that an entirely inspirational type of chemistry without real chemical technique does not challenge the student, but loses his respect.[2]

The year 1910 saw pronounced trends towards the development of social objectives, towards more emphasis on the practicability of the science, and towards a better adaptation to the needs and interests of the pupils.[3] Only today are we beginning to accomplish these objectives with the help of the visual method. In the Boston Sunday Globe, page twenty-four, March 6, 1932, an article written on visual education by three Boston University experimenters asks, "What shall the children see in order that they may believe the teacher isn't talking theories, but is actually discussing problems which they will have to face daily?" Again this question shows the position of the teacher, even with visual aids. However, where the textbook is given a too prominent place in a study, it is not easy to make room for other material, no matter what its form or nature.[4]

Once the teacher has selected his aims and objectives to be accomplished in his course, he has to decide what subject matter will best lead in approaching these aims.[5]

1. High School Science and Mathematics, Olympia, p. 68
2. B. C. Hendricks, How to Teach Chemistry, p. 312
3. P. J. Fay, The History of Chemistry Teaching in American High Schools, Vol. 8, pp. 1533-62
4. D. C. Knowlton, Visual Instruction, p. 953
5. E. W. Phelan and C. S. Rose, Objectives as Aids, etc. pp. 831-5

Since this paper has sounded again the new aim to be accomplished in a beginning chemistry course, it remains to outline the subject. With the soundness of visual instruction as shown in the previous chapters as a supplementary method, it will be the purpose of the outline to show the various types of visual aids that may be used under each unit .

Outline of Course with Visual Aids for High School Chemistry.

Glossary to the Units of Visual Aids.

In a search for visual aids for chemistry, it was found that the Journal of Chemical Education has summarized the films, film slides, stereographs, and glass slides available for the high school up to January 1931,[1] Exhibits, charts and pictures we found in the book, Enriched Teaching of Science in the High School by Woodring, Oakes and Brown.[2]

As was suggested in the previous chapter, the course was divided into units. Under each unit the visual aids available were placed. The column to the left, titled "Types of Visual Aid" has the following letters standing for:

C -- Chart
E -- Exhibit
F -- Moving picture
F.S. -- Film slide
G.S. -- Glass slide
P -- Posters
S -- Stereographs

The second column has the title of the Visual Aid, and the third column has a letter standing for the source of the visual aids.

1. Visual Aids in Chemical Education, J.C.E., Vol. 7, pp. 2916-2927 and Vol. 8, pp. 128-132
2. Woodring, Oakes and Brown, Enriched Teaching of Science in the High School.

W -- Enriched Teaching of Science in the High School Woodring, Oakes and Brown, Teachers College, N.Y.C. 1928

J -- Journal of Chemical Education, Vol. 7, Dec. 1930, and Vol. 8, Jan. 1931

K -- George Kleine, 804 S. Wabash Avenue, Chicago, Illinois

B -- Bray Productions, Inc., 729 7th Ave., N.Y.C.

The sources W and J have names and addresses of the distributors of the various types of visual aids. Before any further discourse, an examination of the eight Units would be of value:

Unit I   Matter Undergoing Change

Type of Visual Aid	Title of Visual Aid	Source of Visual Aid
C	Melting Points of Chemical Elements	W
C	English and Metric Units	W
F	Liquid Air	J
F	Buried Sunshine (carbon)	J
F	Carbon Monoxide, the Unseen Danger	J
F	Chemistry	J
F	Experiments in Chemistry	J
F	Chemistry of Combustion	J
F	Oxygen the Wonder-Worker	J
F	Oxygen Breathing Apparatus	J
F	Science at Home (Properties of the Atmosphere)	W
S	Industries of America	J
F.S.	Oxygen	J

F.S.	Nitrogen and Carbon dioxide	J
G.S.	Introduction to Chemistry	J
G.S.	Hydrogen	J
G.S.	Nitrogen	J
G.S.	Carbon	J

UNIT II Water, Solution and Crystallization

Type of Visual Aid	Title of Visual Aid	Source of Visual Aid
E	The Permutit Process	W
F	A Modern Sewage Treatment Plant	J
F	Purifying Water	J
F	Work of Underground Water	J
F	Beyond the Microscope	J
F	Crystals in Formation	K
F	Experiments in Crystallization	B
F.S.	Ice and Refrigeration	J
F.S.	The Chemistry of Water Treatment	J
F.S.	Ice: Natural and Artificial	J
G.S.	Water	J
G.S.	Crystal Systems	J

Unit III The General Properties of Gases

Type of Visual Aid	Title of Visual Aid	Source of Visual Aid
F	The Science of Bubbles	J

Unit IV The Atom and Molecule

Type of Visual Aid	Title of Visual Aid	Source of Visual Aid
F	Beyond the Microscope	J
G.S.	Atoms and Molecules	J

Unit V Valence, Ionization, Acids, Bases, and Salts

Type of Visual Aid	Title of Visual Aid	Source of Visual Aid
F	Chemical Effects of Electricity	J
F	Story of the Storage Battery	J
F	Common salt	J
F	Silver Plating	J
F.S.	Story of Salt	J

Unit VI The Non-Metals and Their Relatives

Type of Visual Aid	Title of Visual Aid	Source of Visual Aid
E	Ammunition	W
E	Cocoon to Silk	W
E	Cement manufacture	W
E	Materials in Manufacture of Glass	W
E	Carborundum	W
E	Materials in Manufacture of Paper	W
P	Periodic Table	W
F	Story of Abrasives	J
F	Dynamite, Concentrated Power	J
F	Explosives - Dusts	J
F	Manufacture of Smokeless Powder	J
F	Romance of Glass	J
F	Story of a Lucifer Match	J
F	The Chilean Nitrate Industry	J
F	Refrigeration	J
F	Silica Gel (Refrigeration)	J

F	Experiments in Sulphur	J
F	Story of Sulphur	J
F	Table Wear	J
F.S.	Glass	J
G.S.	The Halogens	J
G.S.	Sulphur and Sulphides	J
G.S.	Silicon and Boron	J
G.S.	Fertilizers	J

Unit VII The Properties of Metals and Their Compounds

Type of Visual Aid	Title of Visual Aid	Source of Visual Aid
E	Aluminum Cooking Utensil Co.	W
E	International Nickel Co.	W
E	Stainless Steel	W
E	Raw Materials for Ink	W
E	The Steel Pen	W
E	The Various Salts	W
E	Asbestos	W
P	Evolution of tea-kettle from Bauxite	W
C	Lime and Its Uses	W
C	Uses of Zinc	W
F	Making Aluminum Wear Ever Cooking Utensils	J
F	Story of Asbestos	J
F	Enamelware	J
F	Limestone to Marble	J
F	Concrete	J

F	Story of Portland Cement	J
F	Copper Mining and Smelting	J
F	Copper Wire	J
F	Grinnell Sprinkler Head	J
F	Continuous Process of Making Iron and Steel Sheets	J
F	Iron Ore to Pig Iron	J
F	Pig Iron to Steel	J
F	Rolling Steel by Electricity	J
F	Story of Alloy Steel	J
F	Story Your Ink Bottle Tells	J
F	From Pigs to Paint	J
F	Mining Nickel and Copper Ore	J
F	Monel Metal	J
F	Manufacture of Zinc Oxide	J
F	Story of Lead	J
F.S.	Concrete	J
F.S.	Iron and Steel	J
G.S.	Grinnell Automatic Sprinklers	J
G.S.	Manufacture of Portland Cement	J
G.S.	Sodium and Potassium	J
G.S.	Calcium	J
G.S.	Iron and Steel	J

Unit VIII Organic Chemistry - The Compounds of Carbon

Type of Visual Aid	Title of Visual Aid	Source of Visual Aid
E	The Lead Pencil	W
E	The Fountain Pen	W
E	Manufacture of Rubber Tire	W

E	Paraffin Paint Co.	W
E	The Quaker State Oil Refining Co.	W
E	Raw and Refined Sugar	W
E	Materials for Manufacture of Artificial Silk	W
E	Soap: Its Origin, Manufacture and use	W
E	Materials for Making Linoleum	W
C	Anti-Stain Formulary - for removing stains from fabrics	W
C	Products from Coal	W
C	Process and Products of Crude Oil	W
C	Cream of Tartar	W
P	Chemical Steps in Manufacture of Film	W
F	Alcohol	J
F	Story of Bakelite	J
F	Fertilizer from Coal	J
F	Story of Coal	J
F	A B C of Food	J
F	Leavening	J
F	Making Chewing Gum	J
F	Modern Oil Refining	J
F	Story of Gasolene	J
F	Story of Petroleum	J
F	American Glove Craft	J
F	From Tree to Newspaper	J
F	Story of Rubber	J
F	Soap	J
F	Sugar Industry	J
F	From Cocoon to Spool	J

F.S.	Paper	J
F.S.	Petroleum	J
G.S.	Gas Mantles	J
G.S.	Paper	J
G.S.	Soap	J
G.S.	Sugar and Glucose	J

In a comparison of this outline of visual aids, with the Survey of Visual Aids in the ten texts, an important finding was brought out. Let us compare the length of the lists of Table III Unit III, and Table IV, Unit IV, with Unit III and Unit IV, respectively. We will find that the amount of visual aids, as diagrams, used by the texts, are the least in number for Table III Unit III, and Table IV Unit IV, as compared with the other six tables. The same holds for Unit III and Unit IV dealing with other types of visual aids, as compared with the other six Units. From these findings we may come to two conclusions; first, that the films, glass-slides, film-slides, and so forth, are following the texts in that they visualize in various forms, what the text visualizes in diagrams; and, second, that the various units in a chemistry course have limits above which visualization can not be accomplished as yet.

This finding does not, however, discount any value from the glass-slides, films, filmslides, and exhibits, for there are many things that these visual aids can accomplish that a diagram of the same thing can not,

among which is reality.

It was not the purpose of this paper to make a detailed procedure in any unit, for that would be disregarding the position that the teacher should play. Also, it would disregard the present interests of the pupils. This paper has not outlined the teacher demonstrations, for it is felt that each school system sets a minimum number of these to be carried through by the teacher, and leaves to the teacher's discretion other means of presentation of the subject matter.

The Units do not claim to be absolutely tight and limited, for that is not what chemistry is. Each Unit may overlap some other. So it is with the visual aids outlined. A teacher, for example, may be able to use the film "Beyond the Microscope" fittingly in at least four Units.

From a study of the survey of the texts, and the survey in this chapter of other visual aids available, it is felt that a high school chemistry course which will fulfill the new aim - to give the pupils an understanding of the fundamentals of chemistry and their relationship to daily life - can be accomplished.

The purpose of this paper has been accomplished by selecting a representative course of study in the titles of eight units. Reality was brought into this course of study by organizing the aids available as supplements to the text in use. The available visual aids as supplements in teaching the Units should be used in order that we may

bring into the classroom more of the chemistry of everyday life, such as, leavening, soap, sugar, oil, and many other things of daily contact. Again we stress the fact that visual aids of all kinds may accomplish reality, but it alone is not the panacea for education. The many visual aids in the outline have the property of presenting fundamentals of chemistry from the everyday chemistry, thus serving two purposes and two groups of pupils. The two purposes are the two parts of the new aim in chemistry; and the two groups of pupils are those who are not going to college and those who are.

To make a true life-like course in chemistry one would have to go outside of the chemistry room and enumerate all things which have a chemical nature. That is, the chemistry involved in the kitchen, the street, the farm, the factory, the immediate environment, and the distant environment. Then in order to present all this in the classroom it would be necessary, in some cases, to make use of reality in the presentation of the topic in question, and this may well be done by visual aids, and also by the use of the text.

In the outline of the course in this paper all available visual aids were listed under the various units in which they fit. The titles of the diagrams also served as a guide in the topics to be discussed in the class. When the topics require elaboration or more reality the

visual aids are used as the teacher sees fit.

SUMMARY

The Unit plan in chemistry considers every-day chemistry of inks, paper, food, and other daily contacts which pupils make, as part of a regular chemistry course and not supplementary topics to be read outside. The importance of the teacher is not over-stressed in his relation to visual aids. The Units in chemistry may overlap.

CHAPTER VI

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

Visual instruction, which today is not considered as an entirely new method, consists of the selection and grouping of teaching materials and devices. Teacher training, and centralization and organization, are the two key-notes which are sounded for the advance of the visual method in education.

The visual method, when properly presented, supplements the pupil's experiences with new precepts, and does not rehash. In all fairness to the methods used in chemistry we find that visual aids have been long employed; for example, the demonstration and the exhibit.

Learning requires a certain amount of imagery. It has been found that the more vivid the imagery the more effective learning is. Verbalism overdone is nothing more than the memorizing of words, without ideas. With the ever increasing world of facts, the use of more vivid imagery is necessary. Words are not understood by all, while a good visual aid is.

Visual instruction is not a fad that is being forced upon the schools; it is an accepted media of transference of ideas by the commercial world. There are various types of visual aids, and each has its advantages and disadvantages.

The value of the new method was seen by the colleges, who began to give teacher training courses about 1920. Thomas A. Edison was once quoted as saying that all instruction would be by visual means. This claim today is

discounted at least sixty percent by Weber.

To fulfill the aims and objectives in chemistry, visual aids other than the demonstration and laboratory have found their place. Visual aids do not plan to displace the use of the chemistry text, but only supplement it. In a review of the aims of the chemistry texts, it has been decided that the realization of these aims can come about only by the use of visual aids, such as the film, diagram, animated diagram, and exhibit.

The Unit plan of teaching chemistry is pedagogically sound.

A most enlightening finding in the visual aids available, and the survey of the visual aids in the texts, has shown that the visual instruction men are "copying" from the textbooks. If that is true to any great degree, the chance of getting the expected help from visual instruction is far off, but not impossible. It should be the job of the visual instruction men to bring about the presentation of more realism to supplement the textbook.

Visual aids are teaching aids and should be used as such at the time when the visual aid correlates with the subject matter considered.

The validity of visual instruction as a method may be justified in the statement made by Mr. Krasker, Director of Visual Instruction in the Quincy, Massachusetts, schools,

that "by visual education we hope to bring reality before the learner." This, and other statements of the new method, have helped to establish it in the position it holds in its short return to the field of methods.

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